IN THE SPECIFICATION:

Please rewrite the heading at page 1, line 4, so that it reads as follows:

Cross-Reference to ~~related applications~~ Related Applications

Please insert the following heading before "Field of the invention" at page 1:

Background of the Invention

Please rewrite the paragraph at page 1, lines 10-13, so that it reads as follows:

The invention relates to methods for the continuous real time tracking of the position of at least one mobile object in a defined multidimensional ~~space in accordance with the first part of Claim 1 and also to an appertaining device in accordance with the first part of Claim 20.~~ space, and also to an associated apparatus.

Please rewrite the paragraph at page 1, line 15 to page 2, line 2, so that it reads as follows:

For quite some time now, various interest groups have expressed the desire for a system enabling them to study or reconstruct the path followed by moving objects or persons, this presupposing an accurate indication of the position of the object both locally and temporally. Amongst other ~~things hereby,~~ things, balls in play are of especial interest particularly in commercialized types of sport, such as ~~e.g.~~ rapidly accelerating footballs in a three-dimensional space, and likewise, tennis or golf balls. Thus, the question as to who last touched the object in play, how it was hit and in which direction it was further-accelerated can, in dependence on the type of game, be

crucial for the outcome of the game. Meanwhile, the ~~equipments~~ equipment used for the game and ~~which are~~ employed in high performance sports (e.g. tennis balls, golf balls, footballs and the ~~like,~~ like) can now be accelerated to extremely high speeds so that the detection of the object during the movement thereof requires highly ~~differentiated~~ sophisticated techniques. The technical means used so far – predominantly cameras – do not meet the demands outlined above or they do so to only a limited extent; in addition, the methods known until now for determining the position of an object by utilizing different combinations of transmitters and receivers still leave a large margin of error with regard to the spatial resolution of the positional indications, with regard to the handling of the necessary transmitter/receiver components and, above all, with regard to the evaluation of the data received by the transmitter/receiver system so that, in consequence, extremely fast evaluation of the results obtained from this data is not yet possible.

Please rewrite the paragraph at page 2, lines 3-20, so that it reads as follows:

A system for the localization of a mobile object in a predefined area is described in EP 700 525 B1. In concrete terms, it is concerned with the determination of the position of cellular telephones, whereby however, the areas must be spaced from each other by at least 0.5 to 20 miles. The main problem with the navigation of these telephones is that the navigation process should use as little of the available capacity as possible since this capacity is otherwise needed for the accomplishment of the primary tasks of such

telephones, namely, speech transmission. In the case of cellular telephones, the transmitters share the same frequency according to the TDMA principle, this presupposing however that the transmitters are synchronized or initialized, so that interference between the transmitted signals does not ensue here. As a result, boundary conditions arise for this technique which are basically different from those required for mastering the task of detecting the position of a ball in play in a field of just a few square meters in size. Here, the main point of interest lies in the provision of a system of high accuracy which is so robust that it is capable of being moved in a highly accelerated object that is in play. One can therefore exclude the possibility of scaling the technology disclosed in EP 700 525 B1 so as to match the field of application envisaged here since it would not lead to an increase in the accuracy, especially in a three-dimensional space, of a system that must be simultaneously robust.

Please rewrite the paragraph at page 2, lines 31-34, so that it reads as follows:

In ~~the~~ a document by E. Kramar: "Funksysteme für Ortung und Navigation," 1973, published by Berliner Union GmbH Stuttgart, pages 91 - 92, it is mentioned that straight receivers are used as position locating receivers e.g. for the Omega system, for the purposes of determining the position of a mobile object.

Please rewrite the paragraph at page 3, lines 6-11, so that it reads as follows:

A TDMA system that comprises a plurality of user stations which communicate with a base station is described in US ~~6041 046.~~ 6,041,046. To this end, pulsed transmissions are likewise sent out. However, there is no starting point in this document which would assist with solving the problem of continuously tracking the position of a mobile object in real time, in particular a ball in play, in a defined multidimensional space such as a playing field.

Please rewrite the paragraph at page 3, line 25 through page 4, line 5, so that it reads as follows:

Appertaining hereto are:

- GPS type systems: A mobile receiver simultaneously receives the signals from at least 3 transmitters; the receiver can determine its position from the differences in the "Time Of Arrival" (TOA). For the above mentioned type of application, each receiver would have to be equipped with a transmitter which continuously transmits the position thereof to a central computer. In addition, the entire navigational computation is accomplished in the mobile transceiver modules, this therefore corresponding to a complex signal processing system involving high computing power and a vary large amount of storage capacity. Such a system is disclosed in ~~USA~~ US 5,438,518. In order to ensure greater accuracy in regard to the position, signal characteristics relating to the field under observation are

additionally stored centrally in digital fashion and the signal characteristics of the received signal are correlated with the stored information. The disadvantage here, is the substantial and virtually unfeasible miniaturization of the system (see also DE 100 53 959 A1, WO 02/037134 A).

Please rewrite the paragraph at page 4, lines 6-12, so that it reads as follows:

- Radar systems: Transit time measurements using (active) transponders or tags. A transmitter at the edge of the playing field sends out a pulse which is received by the moving object and this sends back an echo after a certain time. The distance between the transmitter and the moving object can then be determined from the total transit time of the signal. In this regard, see ~~US-A~~ US 4,660,039. Simultaneous tracking of many objects with a high level of temporal resolution is very difficult using this technique.

Please rewrite the paragraph at page 4, lines 13-22, so that it reads as follows:

- Directional antennae: The moving objects are tracked by very highly directional antennae, whereby they send out signals which are aligned on the receiving antennae. If at least two antennae are used, then the position can be determined from the angles of alignment of the antennae. This principle is described in ~~US-A~~ US 5,513,854 for locating the position of athletes on a playing field. ~~US-A~~ US 5,583,517 describes a system which is based on the same principle, wherein

the mobile transmitter spreads the signal over many different carriers and the resulting signals are recombined in the receiver in order to be resistant to multi-path propagation. The disadvantage here is that a suitable resolution is only obtained if extremely high frequencies (- > light) are used.

Please rewrite the heading on page 5, line 11, so that it reads as follows:

~~Disclosure of the invention~~ <u>Summary of the Invention</u>

Please rewrite the paragraph at page 5, lines 17-19, so that it reads as follows:

This object ~~is achieved by a method of continuous real time tracking incorporating the features of Claim 1 as well as by an associated device incorporating the features of Claim 20.~~ <u>can be attained by providing a method and apparatus for the continuous real time tracking of the position of at least one mobile object in a defined multidimensional space, wherein at least one mobile transmitter module which is attached to at least one mobile object of the system that is to be analyzed and whose signals are received by a stationary receiving and signal processing network and are processed centrally, wherein the signals emitted by the at least one transmitter module are electromagnetic waves which are transmitted within a frequency band range utilizing a time division multiplex technique, and wherein the method and apparatus are characterized in that the available frequency band is used as a single channel for the purposes of maximizing the accuracy of the position detecting process, and in that the communication process between the</u>

transmitters (S, Sp, Sb) and the receivers (E_1,..., E_n) is based on the principle of pseudo-random time division multiplex using non synchronized pseudo-random patterns, and in that the transmission signals in the different burst transmissions (B) are characterized by a low cross correlation.

Please rewrite the paragraph at page 6, lines 14-32, so that it reads as follows:

It is of particular significance ~~hereby,~~ that the communication process between the transmitters and the receivers is implemented by the mechanism of pseudo-random time division multiplex using burst transmissions of low cross correlation and non synchronized pseudo-random patterns, which can be understood as e.g. a combination of the access mechanisms, time division multiplex and code division multiplex. In the case of time division multiplex (TDMA) (c.f. ~~USA~~ US 6,204,813), the transmitters on the moving objects transmit in time division multiplex so that each transmitter must also contain a receiver which makes a synchronizing pulse available to the transmitter, from which the time point of the burst transmission is then derived. Each transmitter uses a different pseudo-random sequence for the transmitting time point so that different transmitters will always be superimposed or no superimposition will occur at other time points. TDMA thus uses a very uniform pattern which has the same period for the individual transmitters and also synchronizes the periods. By means of a "phase shift" of the periods, one then achieves the effect that the transmitters will never send at the same time. However, that again presupposes that the transmitters are synchronized. In

the case of code division multiplex (CDMA), orthogonal spreading sequences are used for the transmitters so that the transmitters do not have to be synchronized. In the event that the transmitters are at different distances however, the signal from the more distant transmitter is over-laid by that from the closer one.

Please delete the paragraph at page 7, line 22, as follows:

~~Further advantages are apparent from the appended claims.~~

Please rewrite the heading at page 7, line 23 as follows:

~~Short description of the Figures~~ Brief Description of the Drawings

Please rewrite the paragraph at page 7, line 26 through page 8, line 1, so that it reads as follows:

Fig. 1 shows a schematic plan view of a playing field with receivers and transmitters,

Fig. 2 illustrates the search range for the sampling of a burst transmission,

Fig. 3 is a block diagram of a receiver network,

Fig. 4 illustrates a transmission sequence from different transmitters,

Fig. 5 is an illustration of the arrangement of the receivers,

Fig. 6 is a diagram of the networks linking the transmitters and receivers,

Fig. 7 is a schematic illustration of the generation of a burst transmission, and

Fig. 8 is a schematic illustration of a receiver.

Please rewrite the heading at page 8, line 2, so that it reads as follows:

Detailed ~~description~~ Description of ~~preferred exemplary embodiments~~ Preferred Exemplary Embodiments

Please rewrite the paragraph at page 8, lines 7-17, so that it reads as follows:

A method for the continuous real time tracking of the position of at least one mobile object in a defined multidimensional, here three-dimensional, space is portrayed in the Figures. A mobile object in the form of a game object, here a football (that is, a soccer ball), which is characterized by its transmitter Sb and also ~~a player, who is~~ players, who are characterized by ~~his transmitter~~ their transmitters Sp, are illustrated in Fig. 1. Although the method is explained hereinafter on the basis of the mobile objects being in the form of a football and the players in a football match, it should be pointed out that other areas of application are nevertheless conceivable wherein one is concerned with the detection of moving objects with high positional accuracy and temporal resolution, i.e. with the detection of highly dynamic paths of movement. A restriction to the field of application in sport is not to be construed from the following explanation.

Please rewrite the paragraph at page 10, lines 8-29, so that it reads as follows:

At a transmission time point, each transmitter only sends a short burst transmission B which is detected by the receivers E_1 - E_n. Stationary reference transmitters R_1 to R_n

respectively Rx_1 to Rx_n in Fig. 3 serve as position references for minimizing errors and for calibrating the system. These transmit an identification code and signals, which are detected by receivers for the purposes of determining their transit time, in like manner to the at least one mobile transmitter Sb, Sp on the moving object. The reference signals are synchronized by means of a signal frequency SF2 of 250 MHz in the exemplary embodiment. Furthermore, the receivers of Fig. 6 are likewise synchronized with one another by means of a signal frequency SF1 of 25 MHz in the exemplary embodiment depicted in Fig. 6. Hereby, the receivers, which are arranged in a receiving network RN in accordance with Fig. 3, thus receive a first item of information over the clocking line 13, a timing mark over the line 14 and their power supply over the line 15. The data obtained by virtue of these items of information is conveyed together with the detected signals over the data line 17 to the data port DP of a central computer unit CPU so that the position of the mobile object can be determined from the signals conveyed thereto. Reference characters DPE designate a data processing and evaluation unit and reference characters SDD designate a signal/data distributor. The block Rx_n besides of Fig. 3 shows a matrix, wherein δtm_a is the time difference relative to the last timing mark for each receiver transmitter ID and wherein am_n gives the information regarding the quality of the correlation for purposes of hard/soft decision in the controller. Before the game controller C calibrates the mutual transit times of the receivers Rx and synchronizes the receiver network RN. With the

help of the controller C the position of the relative mutual transit times of the Rx is calculated.

Please rewrite the paragraph at page 11, line 23 through page 12, line 2, so that it reads as follows:

Important items of data are obtained in the configuration phase prior to the system switching over into its normal operating mode. This is necessary for the calibration of the system in order to take into account e.g. the transit time in the glass fiber network. Hereby, a system check is also carried out so as to detect possible problems in the various parts thereof such as the receivers. After this phase, the process of synchronizing with the transmitters is effected by means of the correlation function. Basically, the transmitters send temporally equidistant packets of data so as to enable an allocation process to occur. Thus, the synchronization routine must have once "found" a data packet for the respective transmitter whereafter it can then predict the next transmitting time point with a certain degree of accuracy since the transmission pattern is of course known. The trigger logic is controlled accordingly in order to enable the digitized data to be found again in the memory. On the basis of the position in the memory and the deviation from the reference time point determined in the correlation routine, the routine determines the distance data, commencing from the expected transmission time point t_0, utilizing a transit time calculation, in accordance with

Fig. ~~2~~ 2. A search range s within which the next signal must emerge is thereby obtained.

Please rewrite the paragraph at page 16, line 30 through page 17, line 15, so that it reads as follows:

The data transmission generating unit 81 consists of the data burst production unit 81a, the transmitter ID block 81b and the sensor data preparation unit 81c. The data burst production unit 81a processes the sensor data supplied by the sensor data preparation unit 81c with the transmitter identifier from the transmitter ID block 81b which represents a bit sequence specific to each transmitter. The resultant data burst is passed on to the burst transmission generating unit 82. In the case of the ball transmitter, the sensor data comes from an acceleration sensor whilst in the case of the player's transmitter it may contain e.g. medical data. The burst transmission generating unit 82 includes the reference oscillator, the high frequency generating unit, the modulator 82b as well as the output stage 82c. The items of transmission data are initially filtered by means of a data filter 82d in order to reduce the bandwidth and thereby enable them to be modulated by the modulator 82b onto the high frequency carrier. After the BPSK modulation process, the signal is amplified and subsequently filtered in the bandpass filter 82e in order to suppress spurious emissions. The burst transmission is finally radiated via the antenna 83. The timing control unit 80 controls the temporal generation of the data burst and the switching of the output stage 82c according to time division

multiplex techniques. The clock pulse generation is correlated with the reference transmitter 84 receiving the synchronization clock pulse 84d and comprising a glass fiber receiver 84c, filter and clock signal processing ~~84-d~~ unit 84b and an amplifier 84a and with the transmitter Sp,Sb including quartz oscillator 85a and a transistor ~~and~~ in a quartz unit 85b. The clock signal is also influencing the modulator 82b via PIC 82j, PD & Divider 82k, and loop filter 82i including a low pass filter. Reference number 82f designates a level adjustment unit and reference number 82g designates resistors.

Please rewrite the paragraph at page 17, lines 16-34, so that it reads as follows:

Fig. 8 shows the functional blocks of a receiver E. High frequency signals received over the antenna 90 are converted to an intermediate frequency and digitized there with the help of an A/D converter. The digital processing unit 95 obtains therefrom the temporal spacings of the received transmission signals from the individual transmitters with reference to the synchronizing pulses which are distributed by the receiver block 94 containing an LWL receiver to all the components in the receiver E. In addition, the "raw transit time data" generated in this manner is provided with a quality criterion which incorporates the received field strength or the validity of the corresponding measured value before it is passed on to the central computer. The received radio signals are amplified by a low-noise amplifier before they are band-pass filtered. After repeated amplification and filtering processes, mixing takes place in the intermediate frequency range. Since the digitization process is effected by sub-sampling, yet another filtering process must be carried out before a variable

amplification process which provides for a constant level in the A/D converter. The two synchronizing signals are then passed on to the digital signal processing unit as clock pulses, whereby a sampling frequency in the form of the 20 MHz clock pulse SF2 is also supplied to the A/D converter . The digital processing unit contains a network card 95a for submitting the data rate as transit time data 96. A frequency multiplier is arranged between the LWL receiver 94a and the HF-section 91. Reference number 90 designates an antenna, reference number 91 designates a high frequency section, and reference number 93 designates a frequency multiplier.

Please delete pages 20 and 21 in their entirety.

Please replace the abstract, on page 26 of the application, with the rewritten abstract that is attached hereto on a separate page.